TOWARDS AN OMEGA TAXONOMY IN THE DESMIDIACEAE (CHLOROPHYTA)

by

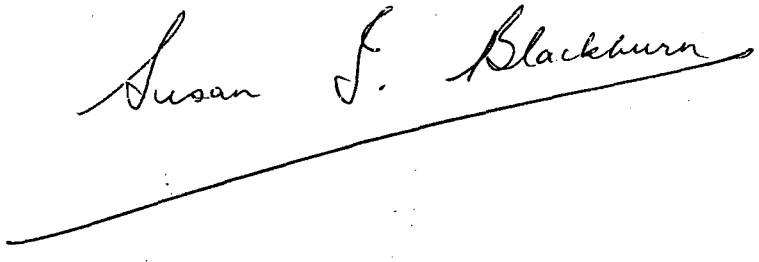
SUSAN I. (Irene) BLACKBURN
(now Susan Irene Edgar)

Submitted in fulfilment of the
requirements for the degree of
Doctor of Philosophy

University of Tasmania
Hobart

June, 1981

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma in any university, and that, to the best of my knowledge and belief, the thesis contains no copy or paraphrase of material previously published or written by another person, except when due reference is made in the text.



ACKNOWLEDGEMENTS

I wish to express my thanks to my supervisor Dr. P.A. Tyler for his support and assistance during the course of my research, and for access to his large reprint collection.

I thank Dr. H.U. Ling for considerable assistance during the early stages of this project with the techniques and skills necessary for the studies.

To Dr. D.P. Thomas I express my most sincere thanks for great encouragement and time consuming help during the writing of this thesis.

I thank Mrs. Rosemary Wickham and Miss Karen Robinson for assistance at various times.

To Professor W.D. Jackson and all the members of the Botany Department I express my thanks for encouragement and support during the years of study.

I am indebted to a number of people who helped my research by sending live algal samples from other parts of Australia and overseas. These include Joan Powling, Dr. J.W.G. Lund, Professor V.W. Proctor and Professor M.C. Grant.

I thank my typist Mrs. Pam Jowitt for such accurate and efficient help in producing this thesis.

To my family I express my most sincere appreciation for the constant moral and practical support over the past few years. In particular I thank my mother for patiently typing a thesis draft and for other assistance, and my husband, Graham Edgar, for vital help in the latter stages of my work.

CONTENTS

ABSTRACT

The systematics of the Desmidiaceae is based upon comparative iconography of cell morphology (alpha taxonomy) with current nomenclature dating from 1848 with the publication of "The British Desmidiaceae" by J. Ralfs. The widespread distribution of many desmids, the diversity of form and the subjective element involved in type specimens being recorded as iconotypes has produced a cumbersome and often ambiguous alpha taxonomy.

In recent years there has been a trend towards a more natural and biologically meaningful taxonomy (omega taxonomy) in higher plants and animals as well as some algae. This, plus the problems associated with desmid alpha taxonomy, instigated this investigation of vegetative and sexual morphology, genetic compatibility, and nuclear cytology in certain desmids. Most of these studies involved the use of unialgal cultures under controlled environmental conditions. In particular two *Micrasterias* species, *M. thomasiana* and *M. mahabuleshwarensis* and related taxa were chosen for their cosmopolitan distributions. This permitted comparisons of the genetic compatibility underlying morphological uniformity, or continua, on a global basis as well as in the more localized situation.

A study of wild and cultured cell morphology of these *Micrasterias* species groups was followed by an investigation of the processes and morphological aspects of sexual reproduction. Sexual compatibility at both the intra-locality (within-population) level and the inter-locality (between-populations) level was tested by a series of crosses, zygospore production being taken as the criterion of sexual compatibility. Genetic compatibility to the extent of viability and fertility of the products of zygospore germination (GP_1) was also examined. In a limited number of cases potential gene flow between strains, which is the ultimate criterion of the "biological species", was investigated by backcrosses of zygospore products to parental strains. In addition, studies of

meiosis and chromosome complements in germination vesicles were undertaken to determine whether a cytogenetic basis existed for taxonomic delimitation.

Similar studies were made on a number of *Pleurotaenium* strains spanning several alpha taxa. However, mitosis in vegetative cells and not meiosis was investigated for selected strains.

Finally a cursory examination of some desmids from tropical Northern Australia was made to investigate diversity and sexual reproduction in the special ecological conditions of this region.

These investigations revealed a genetic complexity within alpha taxonomic species, far exceeding morphological plasticity. Complex patterns of sexual and genetic compatibility within a single locality contrasted with compatibility between strains from the United Kingdom and Australia, and North America and Australia. At the cytological level genetic compatibility was often associated with widely differing chromosome complements, even within a single strain.

The results are discussed with respect to possible dispersal and evolutionary patterns in desmids. It is concluded that at this stage alpha taxonomy must be retained for the desmids but that a more realistic approach to desmid systematics ought to be possible when aided by a knowledge of the genetic variability and compatibility.